CLAIMS

We claim:

1. A method of processing video frame data, comprising the steps of:

receiving a video frame;

partially decoding the video frame;

fully decoding the video frame to produce macroblocks;

determining video data parameters from the partially decoded video frame or both the partially and fully decoded video frame; and

encoding the macroblocks based on the determined video data parameters to provide a compressed video frame for subsequent display.

2. A method according to claim 1, wherein the step of partially decoding the video frame includes variable length decoding an input bitstream of the video frame data.

3. A method according to claim 2, wherein the step of partially decoding the video frame includes variable length decoding the input bitstream for an intra-coded video frame and variable length decoding a compressed anchor video frame bitstream for inter-coded video frames.

4. A method according to claim 3, wherein variable length decoding the compressed anchor frame bitstream includes macroblock address decoding using a macroblock pointer table and the step of determining includes determining macroblock-level and picture-level video data parameters.

5. A method according to claim 4, wherein said macroblock pointer table is organised into video segments, each comprising *n* macroblocks with a full length segment pointer and *n-1* incremental segment pointers, where *n* is an integer.

6. A method according to claim 4, wherein said macroblock address decoding is performed according to:

$$mb\_address_m = segment\_address_k + \sum_{i=0}^{l-1} mb\_address\_inc_i$$

where $mb\_address_m$ is the absolute macroblock address of macroblock m; $segment\_address_k$ is the full segment address of segment k; and $mb\_address\_inc_i$ is the incremental macroblock address of a macroblock with a position offset l within a segment k; and where l is an integer ranging from 0 to n-1 and n represents the number of macroblocks within a segment.

7. A method according to claim 1, wherein the determining step includes one or more of:

(i) determining macroblock-level and picture-level video data parameters;

(ii) determining macroblock complexity in the video frame; and

(iii) determining picture statistics of the video frame.

8. A method according to claim 7, wherein said macroblock-level video data parameters of step (i) include one or more of: an intra coding flag, a bit count of AC coefficients, a bit count of DC coefficients, a quantizer scale, motion vectors, and discrete cosine transform (DCT) type.

9. A method according to claim 7, wherein said picture-level video data parameters of step (i) include one or more of: quantizer scale parameters, intra quantization matrix parameters, intra DC precision parameters, alternate scan format parameters, and intra variable length coding format parameters.

10. A method according to claim 7, wherein the determining step includes estimating the set of macroblock parameters from compressed anchor frames using a decoded motion vector.

11. A method according to claim 10, wherein the step of estimating macroblock parameters from compressed anchor frames for inter-coded macroblocks includes one or more of:

(iv) determining macroblock parameters including a bit count of AC coefficients, a bit count of DC coefficients and a quantizer scale;

(v) determining a discrete cosine transform (DCT) type; and

(vi) determining a minimum quantizer scale.

12. A method according to claim 11, wherein step (iv) is based on a maximal overlap principle where the macroblock assumes characteristics of a compensated macroblock that is maximally overlapped.

13. A method according to claim 11, wherein said determined DCT type is based on a majority of DCT types used in motion compensated macroblocks for inter-coded macroblocks.

14. A method according to claim 11, wherein said minimum quantizer scale is the minimum quantizer scale used among motion compensated macroblocks for inter-coded macroblocks.

15. A method according to claim 11, wherein the step of determining video data parameters from the partially decoded video frame includes step (iv) and the step of determining video parameters from the fully decoded video frame include steps (iv) to (vi), excepting determining said bit count of DC coefficient.

16. A method according to claim 11, wherein the step of determining video data parameters from the partially decoded video frame includes step (iv) and the step of determining video data parameters from the fully decoded video frame include steps (v) to (vi).

17. A method according to claim 11, wherein the step of determining video data parameters from the partially decoded video frame includes steps (iv) to (vi).

18. A method according to claim 7, wherein said macroblock complexity is determined as the product of the macroblock quantizer scale and the bit count of the AC coefficients of the macroblock.

19. A method according to claim 7, wherein said macroblock complexity is estimated from the product of an estimated quantizer scale and an estimated bit count of AC coefficients for inter-coded macroblocks.

20. A method according to claim 7, wherein said picture characteristics include one or more of default DCT type, DC compression factor, picture complexity, a picture bit count of AC coefficients, and a picture bit count of DC coefficients.

21. A method according to claim 20, wherein the default DCT type is a fixed parameter value assigned where equal numbers of motion vectors have DCT type.

22. A method according to claim 20, wherein the DC compression factor is defined as a picture bit count of DC coefficients of the received video frame divided by a picture bit count of a DC coefficients from re-encoded macroblocks.

23. A method according to claim 20, wherein said picture complexity is determined as one of the sum of macroblock complexities of macroblocks in the video frame and the sum of estimated macroblock complexities of macroblocks in the video frame.

24. A method according to claim 20, wherein said picture bit count of AC coefficients is determined as one of the sum of macroblock bit counts of AC coefficients and the sum of estimated macroblock bit counts of AC coefficients.

25. A method according to claim 20, wherein said picture bit count of DC coefficients is determined as the summed accumulation of bit counts of DC coefficients from intra-coded macroblocks multiplied by the DC compression factor and accumulation of estimated bit count of DC coefficients from the inter-coded macroblocks.

26. A method according to claim 1, wherein the step of encoding the macroblocks includes:

(i) allocating target encoding bits for each macroblock;

(ii) predicting a quantizer scale for each macroblock;

(iii) implementing control loop feedback; and

(iv) encoding the macroblock based on said video data parameters.

27. A method according to claim 26, wherein the allocation of target macroblock encoding bits includes scaling of macroblock complexity relative to picture complexity with a feed back control adjustment, as described by the equation:

$$s_i^T = \frac{\widetilde{X}_i}{\widetilde{X}_{pic}} * \left(s_{pic}^T + \xi_{pic}\right)$$

where s_i^T is a target number of bits for encoding AC coefficients for an i^{th} macroblock; $\widetilde{X}_i$ is an estimated complexity for the i^{th} macroblock; $\widetilde{X}_{pic}$ is an estimated complexity from current picture statistics; s_{pic}^T is a target number of bits for encoding all AC coefficients from current picture statistics; and ξ_{pic} is a proportional integral control adjustment for the picture level.

28. A method according to claim 27, wherein said predicted quantizer scale is constrained to be above a minimum quantizer scale.

29. A method according to claim 27, wherein ξ_{pic} is defined by $\eta e_{i-1} + \gamma \sum_{k=0}^{i-1} e_k$ where η and γ are constants and e_i is an error of the i^{th} macroblocks, defined as the difference between the target and re-encoded AC coefficient bit counts.

30. A method according to claim 26, wherein predicting the quantizer scale includes an approximation of a rate quantization with a feedback control adjustment, as described by the equation:

$$\tilde{q}_i = \frac{\tilde{X}_i}{s_i^T} + \xi_{MB}$$

where $\tilde{q}_i$ is a predicted quantizer scale for an i^{th} macroblock; $\tilde{X}_i$ is an estimated complexity of the i^{th} macroblock; s_i^T is a target number of bits used for encoding AC coefficients for the i^{th} macroblock; and ξ_{MB} is a proportional integral control adjustment for the macroblock level.

31. A method according to claim 30, wherein said control loop feedback is based on an error between actual and target encoding bits and provides proportional integral or proportional control adjustments by applying the equation

$$\xi_{MB} = \alpha e_{i-1} + \beta \sum_{k=0}^{i-1} e_k$$

to steps of the macroblock bit allocation and quantizer scale prediction, where α and β are constants less than zero and e_i is an error of the i^{th} macroblock, defined as the difference between the target and re-encoded AC coefficient bit counts.

32. A method according to claim 26, wherein said control loop feedback includes a two tier closed control loop with an inner loop controlling quantizer prediction accuracy and an outer loop compensating for bit rate accuracy.

33. A method according to claim 26, wherein said encoding step (iv) comprises the process of forward DCT transformation, quantization and variable length coding based on said video data parameters, which includes the quantizer scale and a subset of one or more of: DCT type, quantizer scale type, intra quantization matrix, intra DC precision, alternate scale and intra variable length coding format.

34. A video decoding system for processing video frame data, comprising:

means for receiving a video frame;

means for partially decoding the video frame;

means for fully decoding the video frame to produce macroblocks;

means for determining video data parameters from the partially decoded video frame or both the partially and fully decoded video frame; and

means for encoding the macroblocks based on the determined video data parameters to provide a compressed video frame for subsequent display.

35. A video decoder, comprising:

a bitstream parser for receiving a video frame;

an embedded decoder for partially decoding the video frame and fully decoding the video frame to produce macroblocks;

a data analyzer for determining video data parameters from the partially decoded video frame or both the partially and fully decoded video frame; and

an embedded encoder for encoding the macroblocks based on the determined video data.

36. A video decoder system that supports lower resolution picture decoding, comprising:

a video decoderthat includes:

a bitstream parser for receiving a video frame;

an embedded decoder for partially decoding the video frame and fully decoding the video frame to produce macroblocks;

a data analyzer for determining video data parameters from the partially decoded video frame or both the partially and fully decoded video frame; and

an embedded encoder for encoding the macroblocks based on the determined video data;

a decimation filter module for receiving the decoded macroblocks and performing a horizontal spatial decimation of display pixels to the required resolution using a digital decimation filter; and

an interpolation filter module for receiving the decoded macroblocks and performing a horizontal spatial interpolation to achieve a full D1 resolution motion compensation using a digital interpolation filter.

37. A decoder according to claim 36, wherein the data analyzer is structured to perform averaging operations for the lower resolution picture decoding.